

REMARKS

Claims 49-77 are pending in this application.

Claims 49-51, 54-56, 59-62, 72-74, 76 and 77 stand rejected under 35 U.S.C. § 102 as being anticipated by Matsumoto (EU 0360595) ("Matsumoto"). This rejection is respectfully traversed.

The claimed invention relates to a method of forming a photodiode with an ultra-shallow junction. The ultra-shallow junction is provided by forming an ultra-shallow pinned surface layer which has a thickness of about 100 Angstroms to about 500 Angstroms and which provides maximized blue light absorption and reduced leakage.

Independent claim 49 recites a "method of forming a photodiode for a pixel sensor cell" by *inter alia* "forming a gate of a transistor over a substrate" and "forming a first doped layer of a first conductivity type in said substrate and adjacent said gate, said first doped layer being formed to a thickness of about 100 Angstroms to about 500 Angstroms." Independent claim 49 also recites "forming a doped region of a second conductivity type in said substrate and below said first doped layer."

Matsumoto relates to a solid state imager. According to Matsumoto, "in the principal surface portion of an impurity region of first conductive type composing a PN junction photo diode, an impurity region of reverse conductive type is formed in the almost entire region except for a part of side area of an electric charge reading part." (Abstract). Matsumoto also teaches that "[w]hen the impurity region of reverse conductive type is formed in the principal surface portion of the impurity region of one conductive type, the interface trap level generated in the interface of the semiconductor

substrate and silicon dioxide film on its surface can be reduced, so that the generation of dark current may be significantly decreased.” (Abstract).

Matsumoto fails to anticipate the subject matter of claims 49-51, 54-56, 59-62, 72-74, 76 and 77. Matsumoto does not disclose, teach or suggest all limitations of independent claim 49. Matsumoto does not disclose, teach or suggest “forming a first doped layer of a first conductivity type in said substrate and adjacent said gate, said first doped layer being formed to a thickness of about 100 Angstroms to about 500 Angstroms,” as independent claim 49 recites. Matsumoto teaches the formation of the P-type region 11 (which would arguably correspond to the “first doped layer” of the claimed invention) in the surface portion of the N-type region 5. (Col. 3, lines 32-45). However, Matsumoto teaches that the P-type region 11 is formed to a thickness of 0.5 μ m (col. 3, line 44), which is equal to 5,000 Angstroms, and not equal to 500 Angstroms, as the Office Action mistakenly asserts. Thus, for at least these reasons, Matsumoto fails to anticipate the subject matter of claims 49-51, 54-56, 59-62, 72-74, 76 and 77, and withdrawal of the rejection of these claims is respectfully requested.

Claims 52 and 53 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Matsumoto. This rejection is respectfully traversed.

Claims 52 and 53 depend on independent claim 49 and recite that the first doped layer is formed to “a thickness of about 100 Angstroms to about 300 Angstroms” (claim 52) and to “a thickness of about 250 Angstroms” (claim 53).

The subject matter of claims 52 and 53 would not have been obvious over Matsumoto. Specifically, the Office Action fails to establish a *prima facie* case of obviousness. Courts have generally recognized that a showing of a *prima facie* case of obviousness necessitates three requirements: (i) some suggestion or motivation, either

in the references themselves or in the knowledge of a person of ordinary skill in the art, to modify the reference or combine the reference teachings; (ii) a reasonable expectation of success; and (iii) the prior art references must teach or suggest all claim limitations. See e.g., In re Dembiczak, 175 F.3d 994 (Fed. Cir. 1999); In re Rouffet, 149 F.3d 1350, 1355 (Fed. Cir. 1998); Pro-Mold & Tool Co. v. Great Lakes Plastics, Inc., 75 F.3d 1568, 1573 (Fed. Cir. 1996).

In the present case, Matsumoto fails to disclose, teach or suggest all limitations of independent claim 49 and of dependent claims 52 and 53. As noted above, Matsumoto teaches the formation of P-type region 11 (which would arguably correspond to the “first doped layer” of the claimed invention) to a thickness of 0.5 μ m (col. 3, line 44), which is equal to 5,000 Angstroms, and not equal to 500 Angstroms, as the Office Action mistakenly asserts.

Applicants also note that the assertion in the September 7, 2005 Office Action that “the specification contains no disclosure of either the critical nature of the claimed dimensions or of any unexpected results arising there from” is unsupported. (September 7, 2005 Office Action at 6). The specification clearly emphasizes the importance of the claimed dimensions. The specification notes that “it is desirable for p-n junctions, such as the p-n junction between the p-type pinned layer 24 and the n-type region 26 of FIG. 2, to be very shallow” (application at ¶[0013]). The specification teaches that a shallow pinned surface layer is needed “to ensure that the leakage arising due to surface effects (defects, poor passivation, etc) do not contribute to the photodiode response characteristics” (application at ¶[0014]) and “for an improved high blue response photosensor with suppressed transient-enhanced diffusion” (application at ¶[0015]). The specification also notes that “the invention provides a pinned photodiode with an ultra-shallow pinned layer for maximized blue light absorption” (application at ¶[0016]) so that “a very shallow PN junction is formed

between the ultra-shallow p-type pinned surface layer 188 and the n-type region 126 which allows for maximized blue response in a photosensor" (application at ¶[0056]). Thus, the ranges for the thickness of the first doped layer as recited in claims 49, 52 and 53 are critical for attaining maximum blue response and they do not involve routine optimization within the level of ordinary skill in the art, as the September 7, 2005 Office Action asserts. For at least these reasons, the Office Action fails to establish a *prima facie* case of obviousness, and withdrawal of the rejection of claims 52 and 53 is respectfully requested.

Claims 57, 58, 63 and 64 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Matsumoto in view of Kirkpatrick (U.S. Patent No. 4,151,008) ("Kirkpatrick"). Claims 66, 67 and 71 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Matsumoto in view of Todd (U.S. Patent No. 6,743,738) ("Todd"). Claim 70 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Matsumoto in view of Todd and further in view of Fuse (U.S. Patent No. 4,861,729) ("Fuse"). Claims 68 and 69 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Matsumoto in view of Todd and further in view of Tom (U.S. Patent No. 5,993,766) ("Tom"). These rejections are respectfully traversed.

First, Applicants note that the rejection of claims 57, 58, 63, 64 and 66-71 is predicated on Matsumoto, which fails to disclose, teach or suggest all limitations of claim 49 and of dependent claims 57, 58, 63, 64 and 66-71. Applicants also submit that the additional prior art references have been cited to supplement the deficiencies of Matsumoto with respect to the anneal parameters and boron implantation. None of these references, however, discloses, teaches or suggests a "method of forming a photodiode for a pixel sensor cell" by "forming a gate of a transistor over a substrate" and "forming a first doped layer of a first conductivity type in said substrate and

adjacent said gate, said first doped layer being formed to a thickness of about 100 Angstroms to about 500 Angstroms," as in the claimed invention.

Second, Applicants submit that a person of ordinary skill in the art would not have been motivated to combine the teachings of Matsumoto with those of Kirkpatrick, Todd, Fuse or Tom, to arrive at the claimed invention. To establish a *prima facie* case of obviousness, "[i]t is insufficient that the prior art disclosed the components of the patented device, either separately or used in other combinations; there must be some teaching, suggestion, or incentive to make the combination made by the inventor." Northern Telecom, Inc. v. Datapoint Corp., 908 F.2d 931, 934 (Fed. Cir. 1990). This way, "the inquiry is not whether each element existed in the prior art, but whether the prior art made obvious the invention as a whole for which patentability is claimed." Hartness Int'l, Inc. v. Simplimatic Engineering Co., 819 F.2d 1100, 1108 (Fed. Cir. 1987). Accordingly, a determination of obviousness "must involve more than indiscriminately combining prior art; a motivation or suggestion to combine must exist." Pro-Mold & Tool Co., 75 F.3d at 1573.

The September 7, 2005 Office Action fails to establish a *prima facie* case of obviousness because, as the Court in Northern Telecom, Inc. noted, "[i]t is insufficient that the prior art disclosed the components of the patented device" and there is no "teaching, suggestion, or incentive to make the combination." Northern Telecom, Inc., 908 F.2d at 934. On one hand, the crux of Matsumoto is a PN junction photo diode having an impurity region of reverse conductive type formed in the almost entire region except for a part of side area of an electric charge reading part. On the other hand, Kirkpatrick relates to a pulsed laser or flash lamp that produces a short duration pulse or light for thermal processing and teaches a pulsed light source 12 arranged on a specific platform (Fig. 1), while Todd teaches deposition methods for formation of silicon alloys. Fuse teaches the doping of a sidewall of a capacitor trench by directing

impurities to enter directly the sidewall of the capacitor trench, while Tom is directed to a system for the storage and delivery of a sorbable fluid comprising a dispensing vessel having a sorbent material. Thus, it is clear that the only element which Matsumoto and the additionally cited prior art references have in common is the substrate on which their respective structures are formed. A person of ordinary skill in the art would not have been motivated to combine these disparate references and, for at least these reasons, the Office Action fails to establish a *prima facie* case of obviousness. Withdrawal of the rejection of claims 57, 58, 63, 64 and 66-71 is respectfully requested.

Allowance of the application is solicited.

Dated: October 11, 2005

Respectfully submitted,

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